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उच्च आवृत्ति परावैद्युत ताप संस्थापन पावर आउटपुट ज्ञात करने के लिए परीक्षण पद्धतियाँ

Indian Standard

HIGH FREQUENCY DIELECTRIC HEATING INSTALLATIONS — TEST METHODS FOR THE DETERMINATION OF POWER OUTPUT

ICS 25.180.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

July 1997

Price Group 4

Industrial Electroheat Equipments Sectional Committee, ET 17

NATIONAL FOREWORD

This Indian Standard which is identical to IEC Pub 1308 (1994) 'High-frequency dielectric heating installations — Test methods for the determination of power output' was adopted by Bureau of Indian Standards on the recommendations of the Industrial Electroheat Equipments Sectional Committee, ET 17, and approval of the Electrotechnical Division Council.

The text of the IEC Standard has been approved as suitable for publication as Indian Standard without deviations.

In this standard, certain terminology and conventions are not identical with those used in Indian Standards. Attention is specially drawn to the following:

a) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

Only the English language text in the International Standard has been retained while adoping it in this Indian Standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

In this standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence :

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 50 (841) : 1983 International Electrotechnical Vocabulary — Chapter 841 : Industrial electroheating	IS 1885 (Part 17) : 1979	Technically equivalent
IEC 519-9 : 1987 Safety in electroheat installation – Part 9 : Particular requirements for high frequency dielectric heat installations	IS/IEC 519-9 (1987)	Identical

Indian Standard
HIGH FREQUENCY DIELECTRIC HEATING INSTALLATIONS — TEST METHODS FOR THE DETERMINATION OF POWER OUTPUT

Section 1: General

1.1 Scope and object

This International Standard is applicable to industrial radio- or high-frequency dielectric heating installations used for the purpose of thermal applications such as heating, assembly by melting, melting and drying of partially conductive or non-conductive materials, such as plastics, wood, rubber, textiles, glass, ceramics, paper, foodstuffs, etc., in both normal and protective atmospheres, using, for example, inert gas or vacuum.

This standard relates to high-frequency dielectric heating installations in the frequency range 1 MHz to 300 MHz for power levels of 50 W and above. Comprising high-frequency generators and capacitors for the substance to be heated which, according to the requirements, may also contain the necessary mechanical devices.

The main purpose of this standard is to assist in compliance with the requirements set out in 6.4 of IEC 519-9, when testing electro-heating power sources. It is not primarily intended as a means of representing a potential high-frequency heating application for the requirement of the user. Due to the large variety of dielectric heating applications, any output power figures obtained as a result of these tests should not be taken as representing the amount of power that can be dissipated into a particular dielectric heating installation, but in certain instances the output power figures could be used as an indication of performance.

The amount of power required to heat a product will be dependent, for example, on the type of material, temperature and moisture and on the construction of the electrode system.

This standard relates to equipment normally operating under continuous rated conditions and where the output terminals are easily accessible.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 50(841): 1983, *International Electrotechnical Vocabulary (IEV) – Chapter 841: Industrial electroheating*

IEC 519-9: 1987, *Safety in electroheat installations – Part 9: Particular requirements for high-frequency dielectric heating installations*

1.3 Definitions

For the purpose of this International Standard, the basic definitions are defined in IEC 50(841), IEC 519-9 and supplemented by the following definition.

1.3.1 **high-frequency output power:** Maximum amount of power measured into the test load defined in this standard.

The high-frequency output power will be equal to, or greater than, the rated useful output power.

Section 2: Tests

2.1 Power output test loads

There are three different types of output power test loads for use in high-frequency dielectric heating installations. Only the principals are outlined. Detailed constructions shall conform to known engineering techniques.

2.1.1 *Calorimeter load*

A calorimeter load is used for applications determining the high-frequency output power where the load is assumed to be a combination of capacitance and resistance and for power measurements of about 1 kW and above.

2.1.2 *Matched resistive load*

A matched resistive load is used for applications determining the high-frequency output power where the load is required to be of a specific resistance and for power measurements of 50 W and above.

2.1.3 *Lamp load temperature method*

The lamp load temperature method is used for applications determining the high-frequency output power where neither of the above methods is suitable and for power measurements of 50 W to about 1 kW.

Section 3: Description of tests

3.1 Methods of test and measurements

Measuring devices should not be affected by high-frequency fields.

3.1.1 *Calorimeter load*

Typical examples are shown in figures 1a and 1b, but variations of these designs are acceptable. The measuring element is composed of glass, or a lower loss material and comprises two electrodes manufactured from a non-magnetic material such as copper, aluminium, etc.

The generator output terminals are connected to the two electrodes and water as the power absorbing medium flows through the element. The electrode spacing may be adjustable for load setting purposes. To achieve the correct impedance matching between the generator and the load, it may be necessary to use a tuning circuit, to extract the required output power.

A recommended water flow would be about 1 l/min per kW, but not less than 0,5 l/min per kW.

To avoid localized water temperature hot spots through the element, water shall be thoroughly mixed.

To avoid the formation of steam, which may lead to explosion, the water flow should be monitored, for instance, by means of flow interlocking switches.

The water inlet temperature shall not exceed 35 °C.

The water outlet temperature shall not exceed 60 °C.

The difference between the outlet temperature and the inlet temperature shall be at least 10 K in order to obtain results of an acceptable accuracy.

The specific conductivity of the water shall lie between 200 µS/cm and 600 µS/cm.

The measurement shall be carried out when the load is in thermal equilibrium.

The power output is calculated from the following equation:

$$P = \frac{4{,}1868 \times Q \times \Delta T}{60} \approx 0{,}07 \times Q \times \Delta T$$

where

P is the power output, in kW;

Q is the water flow rate, in l/min;

ΔT is the temperature difference, in kelvins, between water inlet and outlet temperatures.

NOTE – 1 cal = 4,1868 J.

The accuracy of power output measurement shall be within ±5 %.

3.1.2 *Matched resistive load*

The matched resistive load takes the form of a low reactance resistor which can be cooled by natural air convection, by forced air or by water. It is generally connected to the generator by a coaxial feeder at a characteristic impedance of 50 Ω. Other values of characteristic impedances are available and alternative feeders may be used.

The power is obtained by measuring the current or voltage at the resistor and the meter can indicate the power directly as I^2R or V^2/R. The matched resistor loads are commercially available at power levels from tens of watts to hundreds of kilowatts.

Typical accuracies are from ±2,5 % to ±5 % dependent on the particular design.

3.1.3 *Lamp load temperature method*

A typical example is shown in figure 2. A filament lamp h1 is connected to the generator output terminals. To achieve the correct impedance matching between the generator and the load, it may be necessary to use a tuning circuit to extract the required output power. The temperature of the lamp is measured with the generator switched on.

A similar filament lamp h2 is then connected across an adjustable mains supply voltage. The voltage is set to provide the same lamp temperatures as for h1. The voltage and current through the lamp h2 are measured and the product gives the power dissipated which will also be the high-frequency output power of the high-frequency generator.

For power levels greater than can be achieved for one lamp, several lamps can be used but problems may occur with non-uniform temperature levels for the various lamps. The difficulties increase with frequency and with the use of lamps with longer filaments. For frequencies above 30 MHz this method is not recommended, and above 100 MHz, practically not suitable.

In view of dielectric strength and better comparability, the lamps shall be operated at a maximum of 70 % of their rated voltage.

Typical temperature measuring devices could include photoelectric cells (see annex A) or pyrometers. The accuracy of power output measurement shall be within ±5 %.

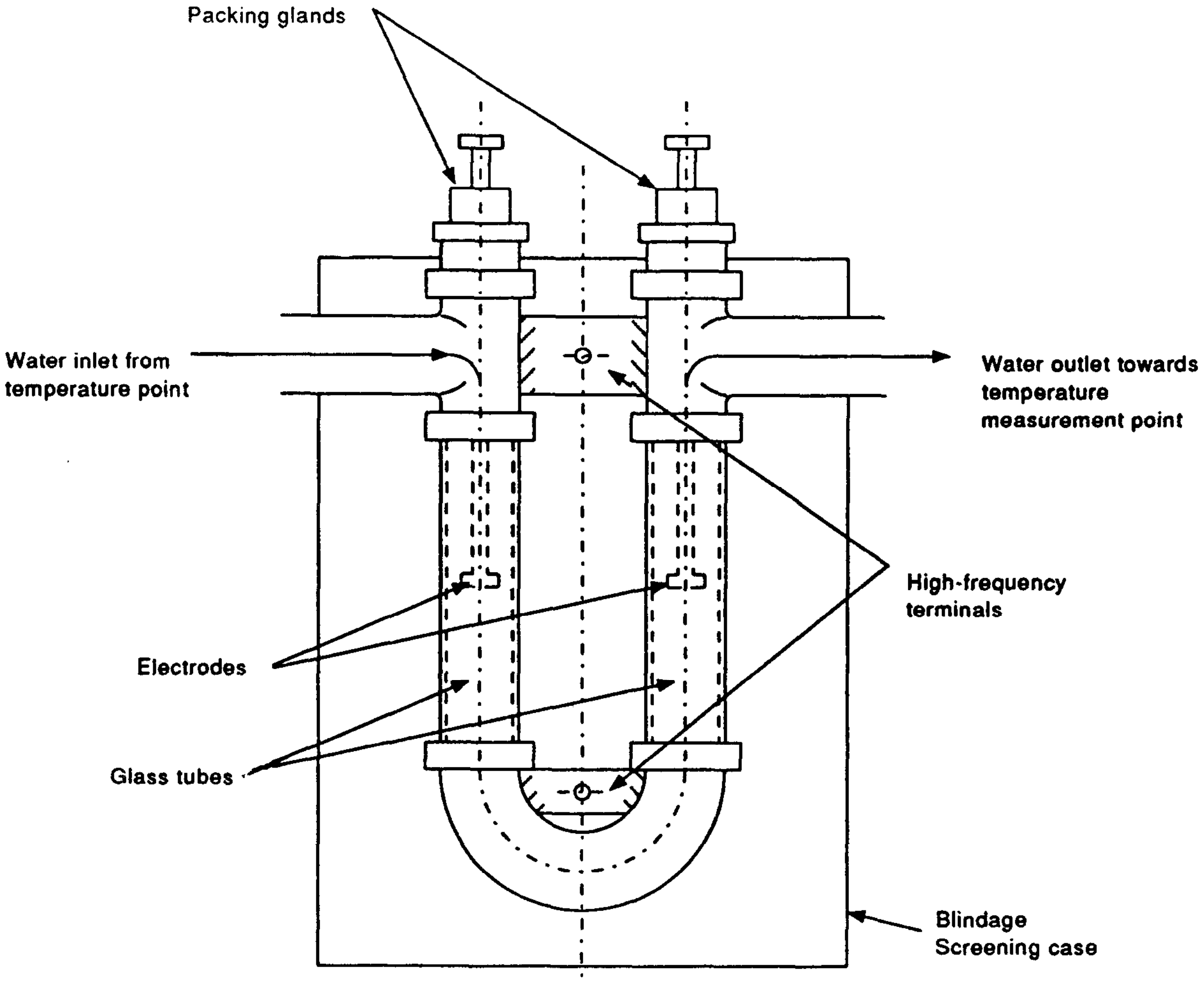

Packing glands
Water inlet from temperature point
Water outlet towards temperature measurement point
High-frequency terminals
Electrodes
Glass tubes
Blindage Screening case

Figure 1a

Figure 1 – Two examples of calorimeter loads

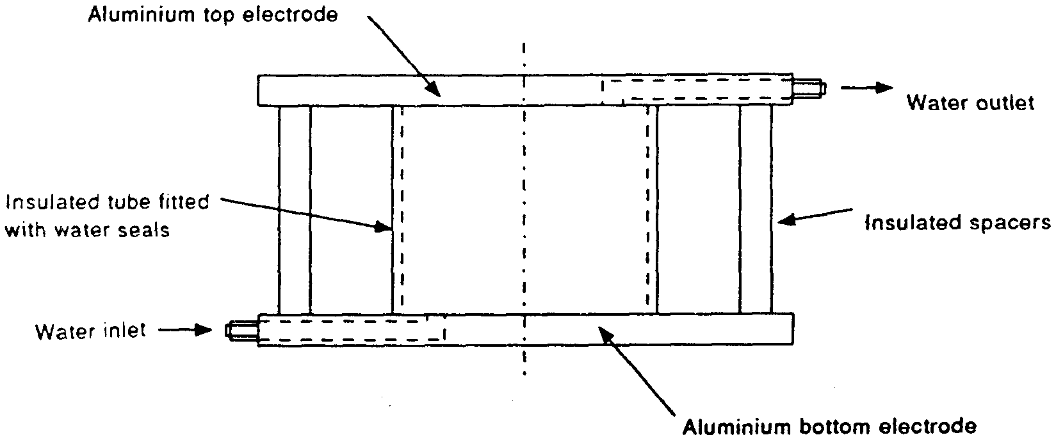
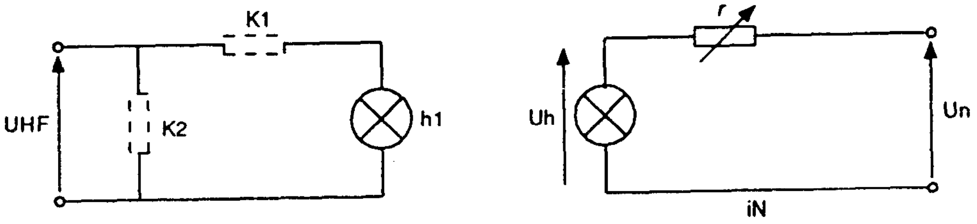

Aluminium top electrode
Water outlet
Insulated tube fitted with water seals
Insulated spacers
Water inlet
Aluminium bottom electrode

Figure 1b

Figure 1 – Two examples of calorimeter loads



K1, K2	Additional reactances
r	Regulation resistor
h1, h2	Comparison lamps
Un	Mains voltage
Uh	Lamp voltage
UHF	High-frequency voltage from generator
iN	Lamp current

Figure 2 – Example of photoelectric method

Annex A
(informative)

A recommended test circuit for the lamp load method

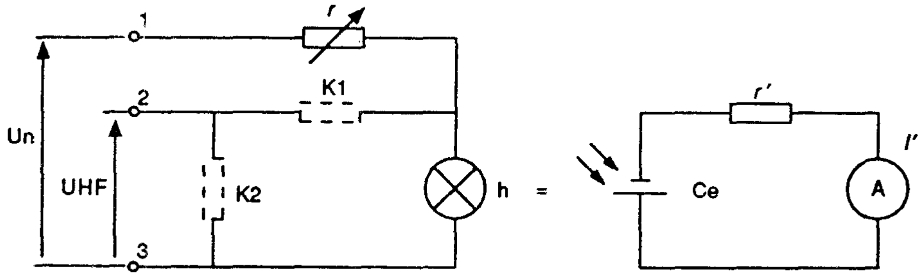


Figure A.1 – A recommended test circuit for the lamp load method

In the figure A.1, Ce is a silicon photo-electric cell and produces, under the radiation of filament lamp h, d.c. current I' in the circuit consisting of Ce, resistor r' and d.c. ammeter A. The meanings of other symbols are the same as in figure 2.

First, the lamp h is connected to the mains voltage Un through terminals 1 and 3, and resistor r is regulated to variate the brightness of the lamp h. The voltage and current through the lamp h are measured and their product gives the power P. At the same time, the current I' is measured. Then the curve of $P = f(I')$ can be drawn.

The lamp h is then connected to the high-frequency voltage UHF through terminals 2 and 3. Current I' is measured and the high-frequency output power of the high-frequency generator can be obtained from the curve of $P = f(I')$.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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